U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-268 306

Calaveras Lake
Bexar County, Texas

National Eutrophication Survey, Corvallis, Oreg

Prepared for

Corvallis Environmental Research Lab, Oreg

Feb 77

PB 268 306

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY
WORKING PAPER SERIES

CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON
and
ENVIRONMENTAL MONITORING & SUPPORT LABORATORY - LAS VEGAS, NEVADA

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

☆ G.P.O. 699-440

REPORT

ON

CALAVERAS LAKE

BEXAR COUNTY

TEXAS

EPA REGION VI

WORKING PAPER NO. 638

WITH THE COOPERATION OF THE

TEXAS WATER QUALITY BOARD

AND THE

TEXAS NATIONAL GUARD

FEBRUARY, 1977

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

1. REPORT NO.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE Report on Calaveras Lake, Bexar County, Texas	5. REPORT DATE Prepared February 1977 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Anonymous (National Eutrophication Survey Staff)	8. PERFORMING ORGANIZATION REPORT NO. Working Paper # 638
9. PERFORMING ORGANIZATION NAME AND ADDRESS National Eutrophication Survey U.S. Environmental Protection Agency 200 S. W. 35th St. Corvallis, Oregon 97330	10. PROGRAM ELEMENT NO. 11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS Office of Research and Development U.S. Environmental Protection Agency 401 M Street, S. W. Washington, DC 20460	13. TYPE OF REPORT AND PERIOD COVERED Final - 1974 14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

Prepared in cooperation with the U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada 89114

16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Eutrophication Lakes Nutrients Phosphorus Nitrogen Loading		08H 05C
18. DISTRIBUTION STATEMENT Release unlimited	19. SECURITY CLASS (This Report) 20. SECURITY CLASS (This page)	21. NO. OF PAGES 46 22. PRICE PC A03 MF A01

EPA Form 2220-1 (9-73)

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Texas Water Quality Board for professional involvement, to the Texas National Guard for conducting the tributary sampling phase of the Survey, and to those Texas wastewater treatment plant operators who voluntarily provided effluent samples.

Hugh C. Yantis, Jr., Executive Director of the Texas Water Quality Board, and John B. Latchford, Jr., Director, and the staff of the Field Operations Division provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

Major General Thomas Bishop, the Adjutant General of Texas, and Project Officer Colonel William L. Seals, who directed the volunteer efforts of the Texas National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

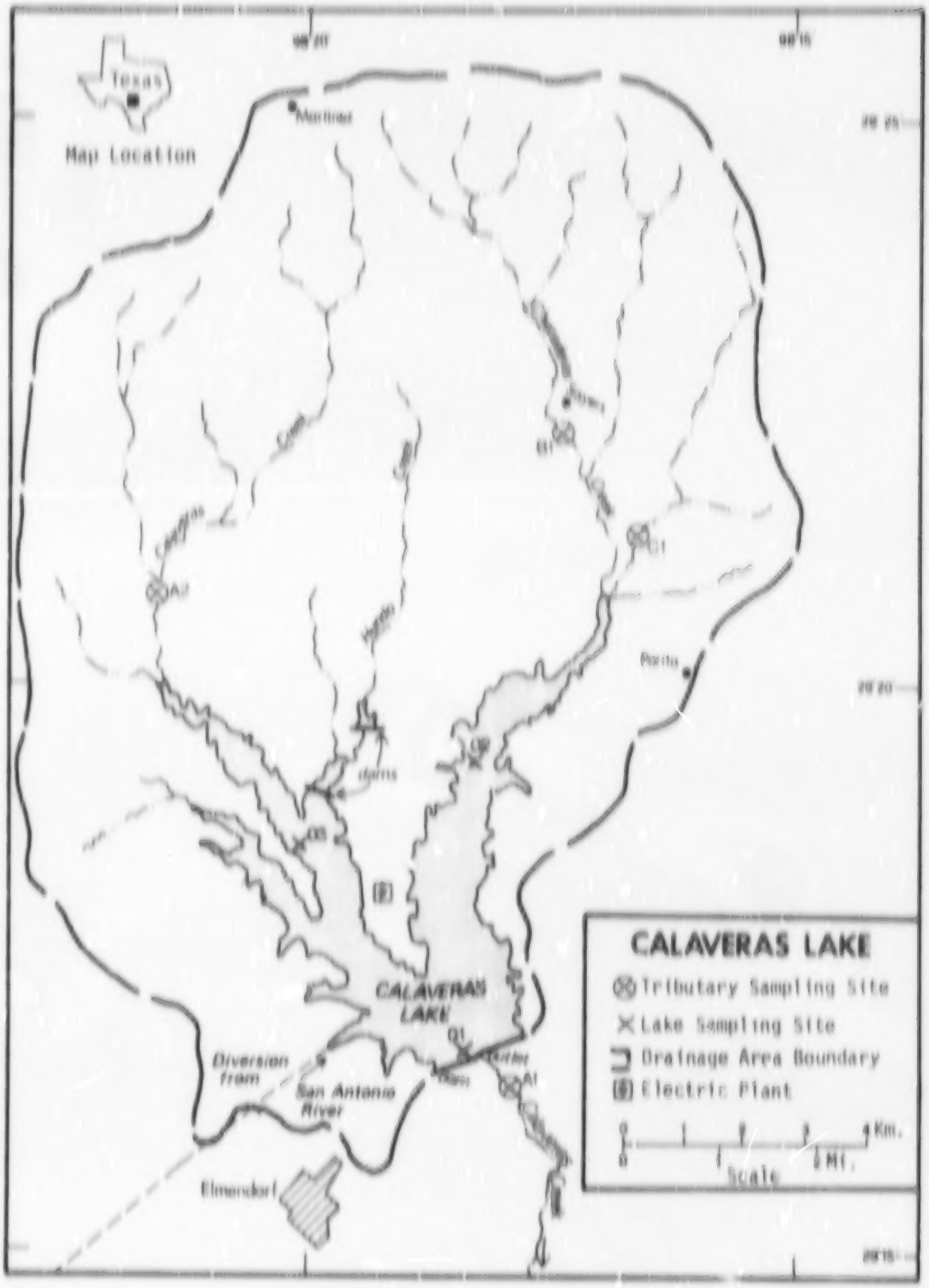
NATIONAL EUTROPHICATION SURVEY

STUDY RESERVOIRS

State of Texas

NAME	COUNTY
Amistad	Val Verde
Bastrop	Bastrop
Belton	Bell, Coryell
Braunig	Bexar
Brownwood	Brown
Buchanan	Burnet, Llano
Caddo	Harrison, Marion, TX; Caddo Parish, LA
Calaveras	Bexar
Canyon	Comal
Colorado City	Mitchell
Corpus Christi	Jim Wells, Live Oak, San Patricio
Diversion	Archer, Baylor
Eagle Mountain	Tarrant, Wise
Fort Phantom Hill	Jones
Houston	Harris
Kemp	Baylor
Lake O'The Pines	Camp, Marion, Morris, Upshur
Lavon	Collin
Lewisville (Garza-Little Elm)	Denton
Livingston	Polk, San Jacinto, Trinity, Walker

Lyndon B. Johnson	Burnet, Llano
Medina	Bandera, Medina
Meredith	Hutchinson, Moore, Potter
O. C. Fisher (San Angelo)	Tom Green
Palestine	Anderson, Cherokee, Henderson, Smith
Permian Kingdom	Palo Pinto, Stephens, Young
Sam Rayburn	Angelina, Jasper, Nacogdoches, Sabine, San Augustine
Somerville	Burleson, Lee, Washington
T. V. Spence	Coke
Stanford	Haskell
Stillhouse Hollow	Bell
Tawakoni	Hunt, Rains, Van Zandt
Texoma	Cooke, Grayson [illegible], Bryan, Johnston, Love, Marshall, [illegible]
Travis	Burnet, Travis
Trinidad	Henderson
Twin Buttes	Tom Green
White River	Crosby
Whitney	Bosque, Hill
Wright Patman (Texarkana)	Bowie, Cass


Texas
Map Location
Martinez
Parita
Alamo
CALAVERAS LAKE
Diversion from San Antonio River
Elmendorf
CALAVERAS LAKE
Tributary Sampling Site
Lake Sampling Site
Drainage Area Boundary
Electric Plant
0 1 2 3 4 Km.
0 1 2 3 Mi.
Scale

CALAVERAS LAKE

STORET NO. 4808

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Calaveras Lake is eutrophic; i.e., well supplied with nutrients and quite productive. Whether nutrient enrichment is beneficial or deleterious depends on the actual or potential effect on the uses of the lake. In this regard, the Texas Water quality Board has indicated that there is little or no known impairment of the designated beneficial uses of this lake.

Calaveras Lake ranked fourteenth in overall trophic quality when the 39 Texas reservoirs sampled in 1974 were compared using a combination of six water quality parameters*. Twenty-one of the reservoirs had less median total phosphorus, two had less and five had the same median dissolved orthophosphorus, none of the others had less but one had the same median inorganic nitrogen, 34 reservoirs had less mean chlorophyll a, and 20 had greater mean Secchi disc transparency.

Survey limnologists noted emergent macrophytes along the shoreline at station 1 in August and at stations 2 and 3 in November.

* See Appendix A.

B. Rate-Limiting Nutrient:

The algal assay results are not considered representative of conditions in the lake at the time the samples were collected due to a significant change in nutrient concentrations during shipment of the samples from the field to the laboratory.

The lake data indicate nitrogen limitation at all sampling times.

C. Nutrient Controllability:

1. Point sources--No point sources were known to discharge to the Calaveras Lake drainage basin during the sampling year. However, the phosphorus load in the diversion from the San Antonio River accounts for almost the entire load to the lake, and it is likely that the wastewater treatment facilities at San Antonio contribute to the enrichment of Calaveras Lake. It is reported that in water year 1975 (10/01/74-09/30/75) the San Antonio Salado Creek and Rilling Road plants discharged 21,993,126 m^3 (60,255 m^3/day) and 114,393,860 m^3 (313,408 m^3/day) of sewage effluent, respectively, to the San Antonio River at points 12.1 and 24.9 km upstream from the point of diversion to Calaveras Lake (Anonymous, 1976).

The present phosphorus loading of 0.76 g/m^2/year is over six times that proposed by Vollenweider (Vollenweider and Dillon, 1974) as a eutrophic loading (see page 15). Improvement of the present trophic condition is dependent upon the reduction of the load in the San Antonio River. Minimization of point-source phosphorus could result in persistent phosphorus limitation of primary productivity in the lake.

F. Non-point sources--the apparent non-point-source phosphorus contribution accounted for all of the total phosphorus load during the sampling year. Calaveras Creek contributed 1.4%, Chupaderas Creek contributed 0.6%, Unnamed Stream C-3 contributed 0.4%, and the San Antonio River diversion contributed an estimated 92.2%. The ungaged minor tributaries and immediate drainage contributed an estimated 3.1%. However, as noted above, much of the load in the diversion from the San Antonio River is contributed by upstream point sources rather than non-point sources.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS†

A. Lake Morphometry††:

1. Surface area: 13.96 kilometers².

2. Mean depth: 5.5 meters.

3. Maximum depth: >9.1 meters.

4. Volume: 76,780 x 10^6 a^3.

5. Mean hydraulic retention time: 20 years (based on outflow).

B. Tributary and Outlet:
(See Appendix C for flow data)

1. Tributaries -

Name	Drainage area (km^2)†††	Mean flow (m^3/sec)†††
Calaveras Creek	32.9	0.040
Chupaderas Creek	20.7	0.030
Unnamed Stream C-1	6.7	0.010
San Antonio River diversion	-	0.161*
Minor tributaries & immediate drainage -	100.3	0.150
Totals	160.6	0.413

2. Outlet -

Generating plant diversion	-	0.122
Calaveras Creek	174.6**	0.000 (intermittent flow)
Total	174.6	0.122***

C. Precipitation****:

1. Year of sampling: 94.0 centimeters.

2. Mean annual: 70.0 centimeters.

† Table of metric conversions--Appendix B.
†† Latchford, 1974.
††† For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976".
* Vost, 1976.
** Includes area of lake.
*** Outflow adjusted to equal sum of inflows minus evaporation; see page 11.
**** See Working Paper No. 175.

III. LAKE WATER QUALITY SUMMARY

Calaveras Lake was sampled four times in 1974 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from a number of depths at three stations on the lake (see map, page vi). During each visit, a single depth-integrated (4.6 m or near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the first and last visits, a single 18.9-liter depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 9.4 meters at station 1, 4.3 meters at station 2, and 4.9 meters at station 3.

The sampling results are presented in full in Appendix D and are summarized in the following table (the August nutrient samples were not properly preserved and were not analyzed).

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6. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
01/13/74	1. Merismopedia sp.	3,032
	2. Chroomonas sp.	2,592
	3. Dactylococcopsis sp.	2,298
	4. Nitzschia sp.	1,467
	5. Cryptomonas sp.	1,320
	Other genera	9,488
	Total	20,197
05/23/74	1. Dactylococcopsis sp.	3,190
	2. Nitzschia sp.	1,202
	3. Merismopedia sp.	1,110
	4. Anabaenopsis sp.	833
	5. Melosira sp.	832
	Other genera	6,288
	Total	13,455
08/16/74	1. Oscillatoria sp.	2,950
	2. Lyngbya sp.	2,397
	3. Raphidiopsis sp.	1,696
	4. Merismopedia sp.	1,217
	5. Anabaenopsis sp.	1,107
	Other genera	7,192
	Total	16,559
11/05/74	1. Oscillatoria sp.	7,756
	2. Dactylococcopsis sp.	3,283
	3. Centric diatoms	930
	4. Raphidiopsis sp.	649
	5. Pennate diatoms	577
	Other genera	2,202
	Total	15,405

A. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (µg/l)
03/13/74	1	12.1
	2	13.8
	3	13.0
05/23/74	1	13.1
	2	28.9
	3	55.4
08/16/74	1	26.0
	2	28.0
	3	12.4
11/05/74	1	27.5
	2	24.5
	3	15.3

C. Limiting Nutrient Study:

The algal assay results are not considered representative of conditions in the lake at the time the samples were taken (03/13/74 and 11/05/74) due to significant changes in nutrient concentrations during shipment of the samples from the field to the laboratory.

The lake data indicate nitrogen limitation. The mean inorganic nitrogen to orthophosphorus ratios were 11 to 1 or less at all sampling times, and nitrogen limitation would be expected.

Nitrogen limitation, as indicated by the algal assay or by in-lake nitrogen to phosphorus ratios, does not necessarily mean

that the trophic condition of the lake can be improved by controlling nitrogen inputs. In many cases, the apparent condition of nitrogen limitation results from excessive phosphorus input from point sources and is often accompanied by a corresponding increase in primary production. In such cases, the reversal of the enriched condition depends upon phosphorus control, not nitrogen control.

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the Texas National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page vi), except for the high runoff months of April and May when two samples were collected at one of the sites. Sampling was begun in September, 1974, and was completed in July, 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Texas District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

The water level of the lake is maintained by pumping water from the San Antonio River. Diversions to the lake during the sampling year amounted to 5,785,068 m^3 (0.183 m^3/sec). Water is taken from the lake and used in the cooling towers of an electric plant. Withdrawal of up to 45,639,130 m^3 per year is authorized (Anonymous, 1976; Yost, 1976).

In this report, nutrient loads for sampled tributaries were calculated using mean annual concentrations and the mean annual flows.

Nutrient loads for the diversion from the San Antonio River were calculated using the mean nutrient concentrations measured at the U.S.G.S. water-quality sampling station (08181800 - 518 meters downstream from the pumping station) and the mean annual flow (Anonymous, 1976). Nutrient

loads in the diversion to the electric plant were calculated using the mean nutrient concentrations measured at lake sampling station 1 and the estimated annual flow.

Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the mean concentrations in Chapuderas Creek at station B-1 and the mean annual ZZ flow.

A. Waste Sources:

1. Known municipal - None in immediate drainage.

2. Known industrial - None.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/ yr	% of Total
a. Tributaries (non-point load) -		
Calaveras Creek	145	1.4
Chupaderos Creek	65	0.6
Unnamed Stream C-1	40	0.4
San Antonio River diversion	9,730	92.2
b. Minor tributaries & immediate drainage (non-point load) -	325	3.1
c. Known municipal STP's - None	-	-
d. Septic tanks - None	-	-
e. Known industrial - None	-	-
f. Direct precipitation* -	245	2.3
Total	10,550	100.0

2. Outputs -

Lake outlet - Generating plant diversion	175
Calaveras Creek	- (intermittent flow)
Total	175

3. Net annual P accumulation - 10,375 kg.

* See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (non-point load) -		
Calaveras Creek	1,535	2.8
Chupaderas Creek	1,155	2.1
Unnamed Stream C-1	410	0.7
San Antonio River diversion	31,620	56.8
b. Minor tributaries & immediate drainage (non-point load) -	5,765	10.4
c. Known municipal STP's - None	-	-
d. Septic tanks - None	-	-
e. Known industrial - None	-	-
f. Direct precipitation* -	15,070	27.2
Total	55,455	100.0

2. Outputs -

Late outlet - Generating plant diversion	3,245	
Calaveras Creek	-	(intermittent flow)
Total	3,245	

3. Net annual N accumulation - 52,210 kg.

D. Non-point Nutrient Export by Subdrainage Area:

Tributary	kg P/km²/yr	kg N/km²/yr
Calaveras Creek	4	47
Chupaderas Creek	3	56
Unnamed Stream C-1	6	61

* See Working Paper No. 175.

E. Yearly Loads:

In the following table, the existing phosphorus loadings are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" loading is one at which the receiving water would become eutrophic or remain eutrophic; his "permissible" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic loading would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
grams/m^2/yr	0.76	0.74	4.0	3.7

Vollenweider phosphorus loadings ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Calaveras Lake:

"Dangerous" (eutrophic loading)	0.12
"Permissible" (oligotrophic loading)	0.06

V. LITERATURE REVIEWED

Anonymous, 1976. Water resources data for Texas: Parts 1 and 2. U.S. Geol. Surv., Austin.

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Yost, J. D., 1976. Personal communication (diversions to and from Calaveras Lake). U.S. Geol. Surv., Austin.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

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27	[illegible]	[illegible]	[illegible]
28	[illegible]	[illegible]	[illegible]

LAKES RANKED BY INDEX NO.

RANK	LAKE CODE	LAKE NAME	INDEX NO.
29	4421	LYNDON B JOHNSON LAKE	239
30	4424	TEXOMA LAKE	237
31	4425	SOMERVILLE LAKE	209
32	4427	SAN ANGELO RESERVOIR	200
33	4433	TEXARKANA LAKE	176
34	4435	GRAND LITTLE ELM RESERVO	173
35	4439	TRINIDAD	169
36	4440	BRANUS LAKE	159
37	4441	CORPUS CHRISTI LAKE	155
38	4447	HOUSTON LAKE	139
39	4450	LIVINGSTON LAKE	91

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[illegible] OF LAKES WITH HIGHER VALUES [illegible] OF LAKES WITH HIGHER VALUES

LAKE CODE	LAKE NAME	[illegible] TOTAL P	[illegible] INORG N	SUB- [illegible] CHLPA	[illegible] DALGPA	[illegible] [illegible] TD	[illegible] DISS [illegible]	[illegible] NO
[illegible]	[illegible] LAKE	29 (113)	55 (213)	24 (94)	3 (11)	67 (259)	38 (148)	259
[illegible]	[illegible] LAKE	18 (71)	97 (377)	5 (21)	18 (71)	82 (321)	39 (154)	259
[illegible]	[illegible] [illegible] [illegible]	66 (333)	37 (144)	67 (333)	42 (164)	17 (67)	51 (199)	372
[illegible]	[illegible] LAKE	32 (125)	78 (304)	19 (144)	21 (83)	63 (244)	38 (148)	253
[illegible]	[illegible] LAKE	11 (44)	51 (199)	13 (51)	16 (67)	72 (279)	13 (51)	176
[illegible]	[illegible] LAKE	39 (144)	34 (133)	61 (239)	45 (179)	17 (67)	21 (71)	217
[illegible]	[illegible] LAKE	68 (339)	23 (71)	92 (364)	82 (319)	17 (67)	84 (329)	384
[illegible]	[illegible]	0 (0)	61 (239)	11 (44)	5 (21)	92 (359)	0 (0)	344
[illegible]	[illegible] [illegible] [illegible]	59 (229)	22 (71)	58 (229)	61 (239)	44 (171)	63 (251)	311
[illegible]	[illegible] [illegible] [illegible]	84 (329)	61 (229)	76 (294)	89 (344)	17 (67)	63 (251)	346
[illegible]	[illegible] LAKE	63 (246)	51 (199)	76 (304)	71 (279)	17 (67)	76 (299)	257

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO.
29	4421	LYNDON B JOHNSON LAKE	239
30	4424	TEXOMA LAKE	217
31	4429	SOMERVILLE LAKE	206
32	4426	SAN ANGELO RESERVOIR	200
33	4433	TEXARKANA LAKE	176
34	4415	GRAPEVINE LITTLE ELM RESERVO	173
35	4434	TRINIDAD	169
36	4414	BRYANS LAKE	159
37	4411	CORPUS CHRISTI LAKE	155
38	4417	HOUSTON LAKE	139
39	4409	LIVINGSTON LAKE	41

APPENDIX B

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

TRIBUTARY FLOW DATA

APPENDIX D

PHYSICAL and CHEMICAL DATA

[illegible]

[illegible]
[illegible]
[illegible]
[illegible]

[illegible]

DATE	TIME	DEPTH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FROM	OF		WATER	DO	TRANSP	CNDCTVY	PH	T ALK	NITRATE	TOT KJEL	AMMONIA	PHOSPHTS
TO	DAY	FEET	CENT	MG/L	SECCHI	FIELD	SU	MG/L	MG/L	N TOTAL	MG/L	MG/L P
					INCHES	MICROMHS				MG/L		
7[illegible]/13	14	48	[illegible]	21.4		24	496	8.55	127	0.428	0.[illegible]	0.[illegible]
	14	50	[illegible]	21.4	8.2		449	8.58	127	0.[illegible]	0.[illegible]	0.[illegible]
	14	58	[illegible]	23.4	7.2		485	8.46	127	0.[illegible]	0.[illegible]	0.[illegible]
7[illegible]/13	13	38	[illegible]	24.1		42	583	8.58	117	0.[illegible]	0.[illegible]	0.[illegible]
	13	38	[illegible]	26.2	6.8		577	8.45	124	0.[illegible]	0.[illegible]	0.[illegible]
	13	38	[illegible]	27.2	5.4		575	8.28	124	0.[illegible]	0.[illegible]	0.[illegible]
7[illegible]/16	09	45	[illegible]	18.4	7.8	36	629	8.88				
	09	55	[illegible]	18.8	7.6		625	8.98				
	09	05	[illegible]	24.9	7.8		638	8.98				
7[illegible]/85	15	18	[illegible]	24.1	8.8	24	535	8.52	124	0.[illegible]	0.[illegible]	0.[illegible]
	15	18	[illegible]	24.1	8.6		538	8.46	127	0.[illegible]	0.[illegible]	0.[illegible]
	17	18	[illegible]	23.9	7.8		569	8.36	124	0.[illegible]	0.[illegible]	0.[illegible]

DATE	TIME	DEPTH	[illegible]	[illegible]	[illegible]
FROM	OF		PHOS-TOT	CHLOPHYL	INCUB LT
TO	DAY	FEET	MG/L P	A	PERCENT
				UG/L	
7[illegible]/13	14	58	[illegible]	0.[illegible]	13.8
	14	58	[illegible]	0.[illegible]	
	14	58	[illegible]	0.[illegible]	
7[illegible]/85	13	38	[illegible]	0.[illegible]	26.9
	13	38	[illegible]	0.[illegible]	
	13	38	[illegible]	0.[illegible]	
7[illegible]/24	09	55	[illegible]		29.8
7[illegible]/85	15	18	[illegible]	0.[illegible]	24.5
	15	18	[illegible]	0.[illegible]	
	15	18	[illegible]	0.[illegible]	

* VALUE [illegible] TO BE
LESS THAN INDICATED

[illegible]

DATE	TIME	DEPTH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FROM	OF		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TO	DAY	FEET	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	15	30	[illegible]	23.7		3n	514	[illegible]	12n	[illegible]	[illegible]	[illegible]
	15	45	[illegible]	22.4	0.5		509	[illegible]	125	[illegible]	[illegible]	[illegible]
	15	30	[illegible]	22.6	0.6		505	[illegible]	125	[illegible]	[illegible]	[illegible]
[illegible]	13	45	[illegible]	38.7		3n	619	[illegible]	127	[illegible]	[illegible]	[illegible]
	13	45	[illegible]	29.6	0.9		614	7.45	127	[illegible]	[illegible]	[illegible]
	13	45	[illegible]	24.6	1.7		628	7.75	130	[illegible]	[illegible]	[illegible]
[illegible]	16	45	[illegible]	32.4	1.2	4J	595	[illegible]				
	10	45	[illegible]	32.6	0.8		609	[illegible]				
	10	45	[illegible]	32.6	1.1		604	[illegible]				
[illegible]	15	30	[illegible]	27.1	7.8	2n	562	[illegible]	126	[illegible]	[illegible]	[illegible]
	15	30	[illegible]	25.6	7.6		551	[illegible]	126	[illegible]	[illegible]	[illegible]
	15	30	[illegible]	25.0	4.6		543	[illegible]	126	[illegible]	[illegible]	[illegible]

DATE	TIME	DEPTH	[illegible]	[illegible]	[illegible]
FROM	OF		[illegible]	A	[illegible]
TO	DAY	FEET	[illegible]	[illegible]	[illegible]
[illegible]	15	30	[illegible]	[illegible]	
	15	30	[illegible]		
	15	30	[illegible]		
[illegible]	13	45	[illegible]	[illegible]	
	13	45	[illegible]		
	13	45	[illegible]		
[illegible]	10	45	[illegible]	[illegible]	
	10	45	[illegible]		
[illegible]	15	30	[illegible]	[illegible]	
	15	30	[illegible]		
	15	30	[illegible]		

APPENDIX E

TRIBUTARY DATA

[illegible]

[illegible]

DATE	TIME	DEPTH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FROM	OF		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TO	DAY	FEET	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]
[illegible]

[illegible]

[illegible]

DATE	TIME	DEPTH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FROM	OF		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TO	DAY	FEET	MG/L	MG/L	MG/L	MG/L P	MG/L P
[illegible]	10	35	0.210	0.980	0.829	0.825	0.196
[illegible]	14	40	0.246	2.780	0.831	0.838	0.188
[illegible]	11	00	0.864	0.986	0.824	0.8834	0.825
[illegible]	10	40	0.352	1.100	0.854	0.849	0.188
[illegible]	12	00	0.135	0.986	0.878	0.835	0.826
[illegible]	11	20	0.834	1.100	0.845	0.825	0.146
[illegible]	10	45	0.256	1.150	0.845	0.115	0.856
[illegible]	12	05	0.350	1.980	0.866	0.825	0.176

A VALUE FOLLOWED BY AN
LESS THAN INDICATES

[redacted]

DATE FROM TO	TIME OF DAY	DEPTH FEET	[redacted] NITRATE N+NITRITE N MG/L	[redacted] TOT KJEL N MG/L	[redacted] NITRITE TOTAL MG/L	[redacted] PHOS-DIS ORTHO MG/L P	[redacted] PHOS-TOT MG/L P
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

[redacted]
LESS THAN INDICATED